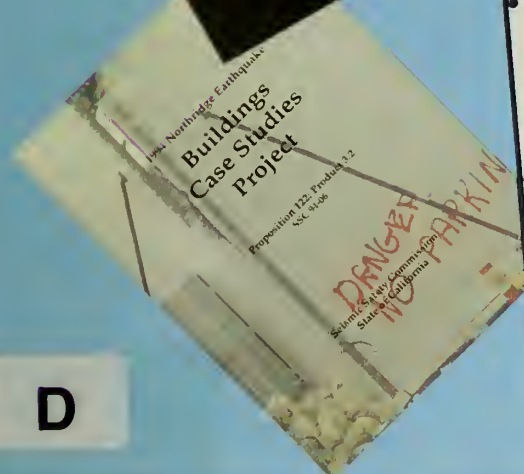
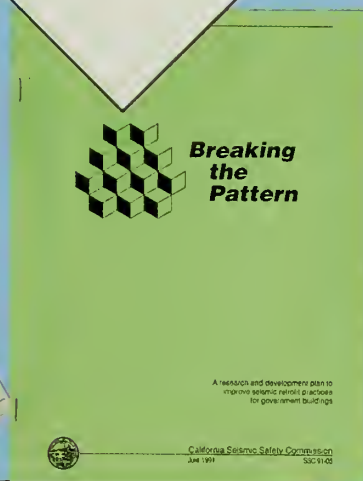
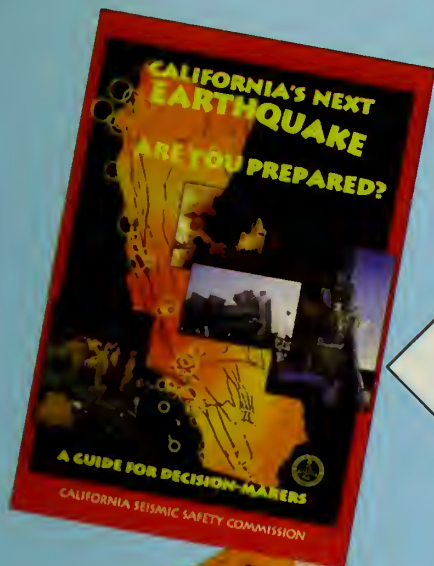




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An Evaluation and Assessment of the California Seismic Safety Commission's Seismic Retrofit Practices Improvement Program Proposition 122



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| | Page |
|--|------|
| Introduction | 2 |
| Purpose of Report | 3 |
| Executive Summary | 4 |
| The Goals Used For the Retrofit Practices Improvement Program | 5 |
| Product 1 – Recommended Seismic Retrofit Provisions & Commentary | 6 |
| • Provisional Commentary for Seismic Retrofit, Product. 1.1, SSC 94-02 | |
| • Seismic Evaluation and Retrofit of Concrete Buildings Volume 1 & 2 Product 1.2 & 1.3, SSC 96-01 | |
| Product 2 – Earthquake Risk Management Tools | 9 |
| • Seismic Risk Management Tools, Product 2.1, SSC 94-05 | |
| • Seismic Risk Management Tools for Decision Makers Product 2.2, SSC 99-04, SSC 99-05 & 99-06 | |
| Product 3 – Short Term Research | 11 |
| • Review of Seismic Research Results of Existing Buildings Product 3.1, SSC 94-03 | |
| • Northridge Earthquake Building Case Studies Product 3.2, SSC 94-07 | |
| Product 4 - Retrofit Information and Education | 13 |
| • Seismic Safety Training for Building Design & Enforcement Professionals, Product 4.1, SSC 99-03 | |
| Recommended Actions to Complete the Program | 15 |
| Acknowledgements | 16 |
| Awards | 16 |
| Program Project Bibliography | 16 |



Proposition 122, passed by the voters in the June 1990 general election, authorized the state to issue \$300 million in general obligation bonds for the seismic retrofit of state-and local public buildings (\$250 million for state-owned buildings and \$50 million for local government essential services facilities).

In response, the Department of General Services (DGS) undertook evaluation of state buildings to determine their seismic risk. Based on this process and criteria, 61 buildings were identified and funded for seismic retrofit using this bond money (*this information was furnished by the Office of Real Estate Services Division (RESO) as of FY 2000-2001*). 132 local government essential services buildings were retrofitted with the bond money and local matching funds. More than 300 high-risk state buildings remain to be retrofitted and with at least 1200-1500 local government buildings remaining to be retrofitted there is clearly a need to continue the program to retrofit state buildings and to expand the state's help to local governments.

Proposition 122 specified that up to 1% or three million (\$3,000,000) of the total bond funds shall be used to support an earthquake research and development program. And further, that these funds were to be used to:

1. Develop methods, techniques, and technologies to identify and analyze existing potentially hazardous buildings and facilities;
2. Develop methods, techniques and technologies for seismic safety retrofitting of buildings, and
3. Help develop building standards and administrative regulations relating to the retrofit of buildings for seismic safety purposes.

The Seismic Safety Commission was given the responsibility of administering this portion of the Proposition 122 Program, which was to capitalize on the seismic retrofit experience developed in the public and private sectors and use that experience to improve seismic retrofit practices applied to government buildings. The mission was to develop products (methodologies, techniques, educational material) for the Seismic Retrofit Practices Improvement Program and make recommendations to further the effectiveness of the Proposition 122 program. The Commission identified the most pressing needs of the time by surveying state and local government agencies and seismic retrofit experts in the private sector. The critical needs were described in the Commission's publication *Breaking the Pattern*. This program, accomplished over a period of ten years, produced four products, which include seven projects, which are described in this report. At the out-set of this program, the Commission created the Oversight Panel for Proposition 122 Seismic Retrofit Practices Improvement Program which comprised of eleven members representing a broad spectrum of the engineering design and construction industry. It was charged with ensuring that the Commission's efforts met the goals and priorities established in its publication *Breaking the Pattern*. The Panel was to monitor the Program and report back to the Commission regularly.

Purpose of Report



This report evaluates and assesses the programs and products developed under the Seismic Safety

Commission's Seismic Retrofit Practices Improvement Program as well as providing recommendations for future retrofit programs involving the remaining state buildings and a large number of local government buildings that have known levels of seismic risk, and that the Proposition 122 bond was unable to fund.



Executive Summary



Californians are fortunate that seismic codes have been written and enforced for the last half century, making California buildings more resistant to withstand earthquakes than buildings located elsewhere. Still, the messages from recent earthquakes are clear. Despite our codes and world-renowned expertise, many of our older buildings and other structures remain vulnerable to earthquake damage.

The Legislature is to be commended for its response to state and local government buildings damaged by the Loma Prieta Earthquake of 1989 and its foresight in its enactment of the \$300 million Earthquake Safety and Public Buildings Rehabilitation Bond Act. The Act was passed by the voters in 1990. From this bond money, over 190 buildings have been seismically retrofitted.

The Seismic Safety Commission's focus was to capitalize on the experience in the public and private sectors and improve seismic retrofit practices for government buildings. With the \$3 million set aside for its Seismic Retrofit Improvement Program, the Commission developed four main conceptual products (methodologies, techniques and educational material) and seven projects for its Program over the span of ten years.

Product Summary

Product 1 – Recommended Retrofit Provisions and Commentary

Product 2 – Earthquake Risk Management Tools

Product 3 – Short Term Research

Product 4 – Retrofit Information

Project Summary

Product 1.1 (1994) Provisional Commentary for Seismic Retrofit

Products 1.2 and 1.3 (1996) Seismic Evaluation and Retrofit of Concrete Buildings

Product 2.1 (1994) Seismic Risk Management Tools

Product 2.2 (1999) Seismic Risk Management Tools for Decision Makers

Product 3.1 (1994) Review of Seismic Research Results

Product 3.2 (1994) Northridge Earthquake Building Case Studies

Product 4.1 (1999) Seismic Safety Training for Building Design and Enforcement Professionals

Summary of Recommended Future Actions

More work remains to be done. There remain more than 300 state buildings at the highest risk levels and 1200-1500 local government building to be retrofitted with an estimated cost of \$1.4 to \$1.5 billion. There is a need to expand the state program to retrofit state buildings, and for the state to assist local governments in retrofitting their buildings.

The Commission's Seismic Retrofit Improvement Program needs to be promoted, monitored and in some cases, updated. It is imperative that the concepts and elements of the program not be forgotten or lost. It needs to be expanded in the following areas:

1. Include retrofit provisions for other types of construction not covered in the current program.
2. Increase and improve outreach of the seismic risk management tools developed.
3. Curricula and training to include builders, trades, local government officials, practicing design professionals, and recent graduates.



The Goals Used for the Retrofit Practices Improvement Program

The intent of the Proposition 122 Program was to provide products that increase the cost effectiveness of retrofitting government buildings and assist governments and in as much as possible the private sector, to make informed decisions about seismic safety. The Program's goal was to increase public safety and enhance quality and consistency in retrofit designs and construction. The Commission's representatives met with key professionals including engineers, architects, building officials, state and local government officials, emergency services personnel, and state agencies, and asked:

- ▷ What are the problems encountered in seismic retrofitting practice, regulation, or administration?
- ▷ What research and development is needed over both the short and long terms to improve the economy and efficiency of seismic retrofitting?
- ▷ If you could recommend only one activity as the single most important to fund under this program, what would it be? Their near-unanimous response in 1991 was the development of seismic retrofit standards, practices and guidelines. The Commission's publication *Breaking the Pattern*, defined and emphasized the goals, priorities and criteria from which the Program evolved.

The goals of this Program were to:

- Help develop professional practices to evaluate the ability of older buildings to withstand earthquakes;
- Help improve retrofit design and construction;
- Judge the effectiveness of retrofits; and determine their benefits and costs.
- Increase awareness of benefits of structural and non-structural retrofit of buildings.
- Enhance awareness of need for planning and risk management.



Recommended Seismic Retrofit Provisions and Commentary

TOPICS OF PRODUCT 1:

- Management of seismic risk
- General principals of seismic design
- Seismic hazard evaluation
- Site response
- New and existing building materials
- Design and construction provisions for seismic retrofit
- Provisions for individual building types

The Provisions and Commentary were developed in a three-stage process:

1. Broad philosophical statement of objective for the design
2. Core of guiding principles
3. Set of provisions for achieving acceptable seismic performance of retrofits

The goal was to be a primary resource for seismic retrofit guidelines until building standards were developed with the help of professional organizations and adopted by professional organizations and state agencies authorized to develop standards such as the Division of the State Architect (DSA), State Historical Building Safety Board and local governments. Another goal was to address different levels of building performance, expected casualty rate, damage to the structure and estimated time to restore buildings to service from their damaged condition.

Documents developed under this product included:

Provisional Commentary for Seismic Retrofit Product. 1.1, SSC 94-02

Objectives

- To develop a report summarizing the present state of knowledge and practice of seismic retrofit for buildings, focusing on three primary structural types that are vulnerable to poor performance and collapse in earthquakes:
1. Non-ductile concrete frame buildings;
 2. Older concrete buildings employing walls and frames for seismic resistance; and
 3. Building frame systems relying on unreinforced masonry walls for stability.

Targeted Audience

- Writers of future seismic retrofit building standards.
- Retrofit design professionals and building officials.
- Government agency personnel and policymakers charged with implementing seismic retrofit programs.

Products

A document that:

- Summarizes existing retrofit design practice and technology in the form of a provisional commentary.
- Points the way to the development of retrofit design guidelines and provisions



The completed report identifies areas where adequate knowledge and consensus exists, key gaps in knowledge, and recommendations for how those gaps might be addressed with future studies. Topics include:

1. Seismic performance objectives and definitions.
2. Seismic forces as applied to existing buildings.
3. Determination of capacities of existing buildings to resist seismic forces.
4. Public tolerance of earthquake damage.
5. Movement (or drift) in existing buildings during earthquakes.
6. Past performance of retrofitted buildings in earthquakes.
7. Retrofit alternatives and their selection.
8. Buildings with irregular configurations.
9. Seismic performance of wall materials.
10. Techniques to strengthen walls.



Assessment and Effectiveness

This product was helpful in many important ways. First, its compilation of early attempts at characterizing performance-based seismic engineering provided a historical platform for future development by both Product 1.2 as well as ATC 33 (Applied Technology Council) (*a federal sponsored program to develop "Guidelines and Commentary for the Seismic Rehabilitation of Buildings"*). Current terms such as "Immediate Occupancy" and "Damage Control" gained acceptance with this product. In addition, a section on life—and function—threatening falling hazards from nonstructural components of buildings or their contents was added.

Early concerns about how to express uncertainty in performance-based seismic engineering identified the need for future ongoing research in this area by organizations such as Pacific Earthquake Engineering Research (PEER) Consortium of Universities for Research Earthquake Engineering (CUREE – *formerly CUREe, California Universities for Research Earthquake Engineering*) and others. The report also laid out decision-making strategies for building owners to consider when confronted with vulnerable buildings. This paved the way for future products 2.1 and 2.2. The Product's evaluation of analytical methods for both the demand from earthquakes and the capacity of buildings gave direction to Product 1.2 as well as ATC 33.

Seismic Evaluation and Retrofit of Concrete Buildings, Volume 1 & 2 Products 1.2 & 1.3, SSC 96-01

Objectives

- To develop a recommended method and commentary for the seismic evaluation and retrofit of older concrete buildings. (Product 1.2)
- To include the effects of foundation response on the seismic performance of existing concrete buildings. (Product 1.3)

Targeted Audience

- The primary audience is retrofit design professionals.
- The secondary audiences are government agency personnel and policymakers charged with implementing retrofit programs.
- An audience-interest spectrum was included at the beginning of each chapter to direct building owners, architects, regulation enforcement officials, engineers and analysts to those chapters that would best serve their needs.

Products

- A two-volume set containing detailed recommendations for how to evaluate and retrofit concrete buildings and foundation systems.
- Four case studies summarizing how the methods work.
- A cost-effectiveness study showing the variation of costs for different seismic performance objectives for retrofits.
- Workshops involving potential users of retrofit products to incorporate their feedback.

Assessment and Effectiveness

The objectives were met. During the first year of this project, the Commission identified that insufficient attention was devoted to the effect foundations have on building performance. As a result, the Commission expanded the scope of this project and added Product 1.3. These products were well received in the retrofit industry. They were developed simultaneously and helped formed the basis for the concrete provisions in ATC 33

(Applied Technology Council), FEMA 273 (Federal Emergency Management) and its capacity spectrum analytical method is now recognized as an alternative method in that publication.

Division III-R (followed by IV-R Code) and regulations were developed by the Division of the State Architect and, more recently revised to VI-R by the Real Estate Services Division of the Department of General Services for all state owned buildings including the University of California and California State University buildings.

The foundation provisions are more detailed than those available in ATC 33, the predecessor to FEMA 273, "NEHRP (National Earthquake Hazard Reduction Program) Guidelines for the Seismic Rehabilitation of Buildings". Several key foundation provisions have been incorporated into later editions and included in FEMA 356 "Pre-standard for the Seismic Rehabilitation of Buildings." Accounting for foundation response in existing buildings can often save considerable construction cost and disruption while gaining a more realistic expectation of the future performance of retrofitted buildings.

Four case studies served to illustrate the strengths and limitations of performance based engineering. They provide a powerful graphical tool for educating new design professionals and training more experienced design professionals who are otherwise unfamiliar with this new type of engineering. Additional case studies have since been performed by FEMA under its project to develop and assess national seismic rehabilitation guidelines (FEMA 343, "Case Studies: An Assessment of the NEHRP Guidelines for the Seismic Rehabilitation of Buildings").

* * *



Earthquake Risk Management Tools

The purpose of this product was to develop objective and reliable methods to evaluate the benefits and costs of retrofits for incorporation into risk management decision-making. The study was also intended to assist facility managers and design professionals in the use of retrofit provisions.

One of the most difficult problems in earthquake risk management decision-making is that certain costs of upgrading are incurred immediately, while the unknown benefits of damage and casualty reduction are realized over an unknown time period at an unknown date. A common observation was that an objective means to measure the costs and benefits of seismic retrofitting was lacking. This was just as significant an impediment to reducing seismic hazards as the lack of retrofit provisions at the beginning of the Program.

Important elements of risk management are:

- A decision framework for retrofit planning and evaluation analysis. It can be used for individual retrofit evaluation and decisions or as a tool to allocate budgets among competing demands.
- The comparative evaluation of a number of buildings with different measurement of relative performance.
- An accepted consensus among government agencies on how such assessments should be accomplished.
- Respond to the technical issues likely to arise in the process: earthquake probabilities, site risk, building type, use, different retrofitting options, historical values, and financial realities.

Documents developed under this product are:

Seismic Risk Management Tools – Product 2.1, SSC 94-05

Objective

- To develop a conceptual paper that outlines the status of benefit-cost and cost-effectiveness procedures as they apply to seismic retrofit.

Targeted Audience

- Managers of state and local government facilities.
- Risk managers, engineering and architectural staffs involved in evaluating the need for seismic retrofit.

Products

- A short technical report summarizing the basics of benefit-cost methods, additional quantitative risk methods, their uses, and limitations.
- A brief non-technical summary describing the advantages and disadvantages of the diverse tools used in public decisions affecting seismic retrofit of buildings.
- A workshop involving potential users of the products to gain their feedback and develop responses to review comments.

Assessment and Effectiveness

The contractor produced two reports and organized a workshop. The most beneficial experience from the project was the workshop in which divergent opinions emerged as to the best methods for making risk management decisions. It became clear that a broader effort would be needed to be successful in this area. This led to the development of Product 2.2.

Seismic Risk Management Tools for Decision Makers–Product 2.2, SSC 99-04, SSC 99-05 & 99-06

Objectives

- Stimulate interest in seismic risk management
- Provide guidelines to identify, evaluate, and mitigate seismically vulnerable facilities
- Enable informed decision-making about seismic risk-reduction
- Demonstrate the benefit-cost and cost-effectiveness of seismic mitigation solutions
- Provide illustrative examples

Target Audience

- Decision-makers such as city managers, mayors, supervisors, agency directors and public works directors





- Facilities managers and risk managers
- Seismic risk management consultants such as building design professionals that include architects and engineers

Products

- *Guide for Decision Makers.* A brochure that provides decision-makers with information and motivation for proactive earthquake risk management.
- *Toolkit for Decision Makers.* A technical report that provides decision-makers with information regarding:
 1. An overview of how earthquake risk is managed to meet objectives.
 2. An in-depth discussion of each step of the earthquake risk management process, via flow-charts and examples to enable informed decision-making about seismic risk reduction and to provide benefit-cost and cost effectiveness of mitigation solutions.
 3. The importance of continued operations
- *Mitigation Success Stories.* Case studies provides descriptions of five successful earthquake mitigation programs to show:
 1. How others in California are mitigating their earthquake risk.
 2. Mitigation can be cost-effective
 3. Insight into the decision-making process

Assessment and Effectiveness

The Western States Policy Council at the National Earthquake Risk Management Conference in Seattle, Washington selected this product as the overall winner for "Excellence in Mitigation" in September 2000. The Commission developed a product that provides an overview of the earthquake risk management process, as well as detailed step-by-step information on how to implement the process.

In most cases the decision-maker will set earthquake risk management as a priority, select or approve specific strategic approaches to risk management, and authorize and monitor progress. However, much of the earthquake risk management work must be done by others, such as department managers, and administrative

and technical support staff. This product provides useful information for all those charged with making decisions and implementation and includes the following:

- *Decision-Maker* — The person who provides strategic direction for the risk management program. Decision-makers include mayors, supervisors, and members of boards.
- *Risk Manager* — The person appointed to develop and implement the risk management program. It may be the City Manager, Director of Public Works, Chief Financial Officer or a designee.
- *Financial Manager* — The person responsible for maintaining the financial accounts for the risk management program. It may be the Chief Financial Officer, Comptroller, or Treasurer.
- *Asset Manager* — The person responsible for maintaining the physical property for the risk management program. It may include the Director of Public Works, Building Official, City Engineer or Facilities Manager.
- *Professional Consultants* — The persons responsible for providing the technical expertise in: 1) building risk screening; 2) equipment risk screening, 3) building risk assessment; and 4) building upgrade design. Typically, these are architects and engineers.

This program is the first major attempt in California to introduce decision-makers, public officials, risk managers and design professionals to earthquake risk management practice and provide a "road map" describing the necessary steps to implement earthquake risk assessment and loss reduction.

Two earthquake-related organizations, with California and national affiliations, the Earthquake Engineering Research Institute (EERI) and the Public Agency Risk Managers Association (PARMA,) have found value and expressed interest in the product publications and are in the process of conducting training sessions for their members. Members of these organizations are among the targeted audience. As outreach is expanded to other earthquake-related groups, the effectiveness of this program will be enhanced.



The purpose of this product was to provide directed short-term research to support the seismic retrofit provisions and commentary and the earthquake risk management tools developed in the first two products.

The specific research needs of this product exceeded the budgetary resources and time constraints of the Commission's Proposition 122 Program. However, with the limited resources available, two projects were funded: A review of available seismic retrofit results, and case studies of twenty-nine buildings that suffered damage during the 1994 Northridge Earthquake.

Documents developed under this Product are:

Review of Seismic Research Results of Existing Buildings – Product 3.1, SSC 94-03

Objective

To identify existing research that is immediately useful to the Proposition 122 Seismic Retrofit Practices Improvement Program.

Targeted Audience

- All those in government and private practice who may be involved in seismic retrofit such as structural engineers, architects, building facility managers, regulation enforcement officials, and all those who may be involved in aspects of building retrofits.
- Architects and engineers experienced in the design of new buildings but who may be designing or reviewing their first retrofit.

Products

- A report summarizing existing experimental and analytical research.
- An outline of expectations for future research needs.
- A correlation of research findings with observations from past earthquakes.
- Evaluations from experienced researchers regarding the possibility of procuring additional information under

the Proposition 122 Seismic Retrofit Practices Improvement Program's budget and time constraints on three structural types:

1. In-fill reinforced and unreinforced masonry wall systems.
2. Non-ductile concrete frame systems
3. Concrete wall and frame systems

Assessment and Effectiveness

These objectives were met with a 497-page compendium characterizing common seismic issues for the above building types and an appendix summarizing existing pertinent research findings.

Photographs and graphical images in chapters 2-4 proved useful in discussing problems with existing research and the need for the development of retrofit guidelines for future projects. The extensive summaries of existing research in the appendix accelerated work under Products 1.2 and 1.3 and also served as a basis for a similar compilation of research results by FEMA during the development of FEMA 273, *NEHRP Guidelines for the Rehabilitation of Existing Buildings* as well as ATC 33.

This report represented the first-time coordinated effort between researchers from the CURE, ATC, and practicing structural engineers from the Structural Engineers Association of California (SEAOC) which formed the SAC Joint Venture (Structural Engineers Association of California, Applied Technology Council, and California Universities for Research in Earthquake Engineering) to work together and are now addressing problems with steel moment frames. The SAC Joint Venture produced a summary of technical research with a strong practical perspective.



Northridge Earthquake
Building Case Studies —
Product 3.2, SSC 94-06

Objective

- To provide a summary of the performance of typical buildings – both retrofitted and unretrofitted – during the Northridge Earthquake of 1994.

Targeted Audience

- Engineering professionals, researchers, and government agency personnel for their use in research, new building designs, seismic evaluations, and retrofits.

Products

- This project developed case studies of 29 buildings - 10 of which were retrofitted before the Northridge earthquake. Studies included a description of the buildings, their earthquake damage, retrofit techniques, post-earthquake repairs, nearby ground motion records, analytical results, conclusions, and recommendations.



Assessment and Effectiveness

Thirty investigators were hired and in less than a year during very busy post-earthquake recovery times. These investigators donated a great deal of their time to document their observations for the benefit of others. This publication

reestablished a tradition of in-depth case studies developed after the 1971 Sylmar Earthquake.

The Commission asked that this Program remain flexible during its course. The report encouraged reassessment of priorities when new circumstances developed or the results of earlier projects generated new recommendations. The Northridge Earthquake provided a prime opportunity to collect new information relevant to performance-based seismic engineering. Governor Pete Wilson issued an Executive Order directing the Commission to examine the adequacy of the building codes. This project served as an important tool in the Commission's efforts to respond to that Executive Order.

The Northridge Earthquake prompted this Program to shift priorities midstream. Since then, the Oversight Panel and Commission decided to focus more on education and outreach to improve quality and reliability in construction

(Product 4). They chose to reduce the amount of funds initially planned for Product 3 research.

Since this project, other researchers, most notably FEMA, restudied several of these buildings. Others have since funded similar case studies for rehabilitation projects in steel and wood frame buildings.

* * *

Retrofit Information and Education

The experience of the 1994 Northridge earthquake showed that, in many respects, building codes and regulations were adequate for life safety but that designers, builders and inspectors lacked the understanding or experience to implement them properly, thereby allowing avoidable failures. The targeted groups for this product were architects, engineers, contractors and building code enforcement officials. These professionals usually lead efforts for the mitigation of earthquake losses; yet often lack specific training in earthquake safety. This product helps to give building design professionals, builders and code enforcers a basic understanding and appreciation for the fundamentals of seismic safety, in particular, as they apply to the seismic retrofit of existing, vulnerable buildings. This product packages and disseminates information critical to the quality assurance of seismic safety in building retrofit design and construction. These products are available for use by public and private sector.

The Program adopted a three-pronged approach to enhance utilization of its products. It began by involving leaders in facilities management, regulation and design in the planning for and construction of the Program. Secondly, many different technical and administrative perspectives were included in the development and peer review of products. Thirdly, products were used to transfer knowledge and motivate their use through pursuit of parallel technology transfer and continuing education approaches.



Documents developed under this product are as follows:

Seismic Safety Training for Building Design and Enforcement Professionals Product 4.1, SSC 99-03

Objectives

- To develop a training program for design professionals and enforcement officials aimed at improving construction quality and seismic safety with a curriculum that provides a clear understanding of earthquake effects on buildings and links those effects to job responsibilities.
- To provide training delivery strategies that includes utilization of new technologies, active participation, and hands-on activities.

Targeted Audience

- Building code enforcement officials, including inspectors, special inspectors, architects, and non-engineer plan checkers
 - Civil and structural engineers involved with building design and plan checking
 - State and local agency personnel who are involved in seismic risk management decisions and building retrofits.

Products

- The primary product is a training notebook, *Built to Resist Earthquakes — The Path of Quality Seismic Design and Construction of Buildings for Architects, Engineers, and Building Officials*. The curriculum consists of training materials pertaining to the seismic design and retrofit of (1) wood-frame buildings, (2) concrete and masonry construction, and (3) nonstructural components. Included are:
 1. Six multi-part, two-color briefing papers intended to generate improvement in the quality of seismic design, inspection, and construction.

2. Detailed illustrated instruction materials (lessons) describing how to improve the quality of seismic design, inspection, construction and retrofit
3. Job Aids — check lists and other tools to facilitate job performance, including construction observation, special inspection and quality assurance procedures.

A pilot training seminar (*one held in Northern California and one in Southern California*) was developed and entitled "Continuing Education Training Seminars on Improving the Quality of Building Seismic Design and Construction." Twelve videotapes of the seminars were developed.

Assessment and Effectiveness

Developed a training program for building design professionals and building regulatory officials to improve construction quality and earthquake resistance of new and retrofitted buildings in California.

Developed training materials that provided a clear understanding of earthquake effects on buildings and link earthquake issues to specific job responsibilities.

Developed training strategies that:

(a) clearly established goals; (b) focused on job performance; (c) provided the big picture; (d) included field materials and job aids; and (e) organized to allow transfer to the targeted audience.

Developed strategies to improve delivery of training: (a) utilize new technology; (b) promote active participation by the targeted audience; and (c) provide more "hands on approaches."

The focus of this project is on wood-frame,

concrete and masonry buildings. Dwellings and low-rise commercial buildings constructed of these materials have performed poorly in recent California earthquakes largely because of the poor quality of seismic design and construction.

The project also studied:

- Nonstructural components, which have experienced and caused extensive damage in recent earthquakes.
- Specific roles of building officials, architects, and structural engineers, in the inspection, seismic design and construction process. Roles and responsibilities were addressed because critical aspects of the design and construction process have frequently been missed or mismanaged due to confusion of which discipline was responsible for carrying out each design, inspection or construction task.
- Steel-frame buildings were excluded from the project for budgetary reasons and because of the extensive ongoing FEMA-funded research being carried out by other agencies.
- The continuing education program developed under this project is intended as a long-term project to be implemented in future years. The primary mechanism for disseminating information developed during this project is a series of "Continuing Education Training Seminars on Improving the Quality of Seismic Design and Construction." In some instances, the seminars will be designed for all three intended audiences for the project (building officials, architects and engineers). In other instances, the seminar program may be tailored to a specific audience. The program's main purpose is to take important first steps to address the state's need in seismic safety training.

* * *



Recommended Actions To Complete the Program



The two primary goals of the Commission's Retrofit Practices Improvement Program were to obtain seismic retrofit designs that consistently and reliably achieve their intended seismic performance objectives, and to achieve cost-effective expenditure of state and local government funds allocated for the seismic retrofit of government buildings.

Specific research remains. The Seismic Safety Commission's Research Committee developed a report "Research and Implementation Plan for Earthquake Risk" (SSC, 94-10). The goal of that Plan is to reduce damage, casualties and interruptions caused by California earthquakes. The Proposition 122 Program addresses a part of the recommendations made in that long-term plan.

The recommended steps following the first goal are to expand seismic evaluations beyond older concrete and masonry buildings to include other types of construction that have suffered earthquake damage. These include wood frame (residential and commercial), tilt-up concrete wall and steel brace frame. The seismic research and case studies need to remain current. The seismic retrofit training curricula and seminars need to be expanded beyond the original target audience of building design and enforcement professionals. The broader audience should include builders, building trades, building officials and inspectors in all state and local jurisdictions throughout the state.

Steps recommended beyond the second goal include a continued effort to disseminate and encourage seismic risk management tools to the targeted audiences of decision makers, risk managers and professional consultants as follows:

- Use of product deliverables
- Raise awareness and follow-up
- Develop risk management workshops

Summary of Recommended Projects And Future Action

Product 1.4 — Make new seismic analysis and advanced techniques such as base isolation, energy dissipation and performance based design into general engineering design specific to California.

Product 1.5 — Advance retrofit methods of wood frame, tilt-up and masonry buildings and nonstructural components.

Product 2.3 — Establish reliability of risk management in performance based design.

Product 3.3 — Develop future research needs and role of PEER in research

Product 4.2 — Modify Product 4.1 curricula to seismic retrofit training of building officials and inspectors in state and local jurisdictions throughout the state.

Product 4.3 — Provide seismic retrofit training for contractors and building trades.

Product 4.4 — Further refine pushover analysis curricula and training for design engineers in seismic retrofit.

Product 4.5 — Develop curricula for consistent basic analysis in the seismic retrofit of wood frame, tilt-up and masonry buildings.

Product 4.6 — Develop curricula and training for seismic retrofit of nonstructural building components.

A coordinated effort among state and local agencies is needed to secure funding to retrofit remaining government facilities that are at seismic risk and expand seismic research and risk management in the seismic retrofit of existing vulnerable buildings and provide for additional training and education. Only with adequate resources and through an ongoing effort can California continue to benefit from the products and reduce the earthquake risk to life and property.



**Seismic
Safety
Commission
Proposition
122
Oversight
Panel
(1991-2001)**

* * *

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Awards

* * *

The Western Seismic Safety Council (WSSC) awarded the Commission the 2000 Overall Winner — Excellence in Mitigation Award for “Risk Management Tools for Decision Makers” project.

The WSSC awarded the Commission the 1997 Award for Overall Excellence and Excellence in New Technology Award” for the Commission’s “Seismic Retrofit Practices Improvement Program” products.

**Program
Projects
Bibliography**

* * *

Program publications are available by order at the Seismic Safety Commission Office 1755 Creekside Oaks Drive Suite 100, Sacramento CA 95814 (916) 263-5506.

Product 1.1, SSC 94-02 — Provisional Commentary for Seismic Retrofit

Products 1.2 and 1.3, SSC 96-01 — Seismic Evaluation and Retrofit of Concrete Buildings

Product 2.1, SSC 94-05 — Seismic Risk Management Tools

Product 2.2, SSC 99-04, 99-05 and 99-06 — Seismic Risk Management Tools for Decision Makers

Product 3.1, SSC 94-03 — Review of Seismic Research Results of Existing Buildings

Product 3.2, SSC 94-07 — Northridge Earthquake Building Case Studies

The following publication is available by order at the Applied Technology Council Office (ATC), phone (650) 598-1542:

Product 4.1, SSC 99-03 — Seismic Safety Training for Building Design and Enforcement Professionals

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